CRITICAL ANALYSIS REGARDING COGNITION OF INTELLIGENT DISTRIBUTION AGENT

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ABSTRACT—*This paper provides a comprehensive analysis of the cognitive features of Intelligent Distribution Agent. Critical analyses of human cognition with reference to the theories that have been proposed are discussed. Prominent theories regarding the artificial cognition are conferred including the famous Global Workspace Theory, which is the heartbeat of Intelligent Distribution Agent for exhibiting cognition. A precise working of the Intelligent Distribution Agent is presented and finally a conclusion is drawn regarding its cognition.*

Keywords: IDA, Cognition, Consciousness

1.0 INTRODUCTION

Intelligent Distribution Agent (IDA) provides a computing model of cognition developed as a software agent. It "resides" on a computer connected to the Internet and different databases, doing work for the US Navy, simulating all the specific employees tasks of a detailer. Particularly, IDA thinks, and makes intended actions selections, negotiates with sailors in natural language for the purpose of discovering new jobs for sailors right at the end with their recent job of responsibility. It completely automates the work of Navy personnel agents (detailers) [1]. Clearly if IDA is cognitive then it should possess all the attributes, which constitutes cognition. These attributes of cognition that are required in any artificial machine depends on the definition of cognition. Different fields like linguistics, anesthesia, neurology along with psychiatry, psychology, anthropology, and computer science have different but somewhat related definitions of cognition and so there is no universally accepted definition of cognition. Science defines cognition as a collection of mind/brain processes including concentration, memory, language understanding, wisdom, reasoning, problem solving, and decision-making. Cognitive systems have been characterized by many as the systems that exhibit adaptive, preventive and purposive goal-directed behavior. In the rest of this paper different definitions of cognition will be explored and if IDA's is an artificial cognitive agent will be discussed.

2.0 LITRERATURE REVIEW

The word cognition has been derived from the Latin verb cognosco where con means 'with' and gnosco means 'know'. Hence generally cognition means 'to conceptualize' or 'to recognize' [2]. A variety of professions such as psychology, philosophy and linguistics all study cognition. The interpretation of word cognition however varies across disciplines for example in psychology and cognitive science it means an information processing view of an individual's psychosomatic functions [3]. Cognition means having capability to recognize just how things may well perhaps be at present and future and utilizing this information when deciding how to act. Memory is also important since recalling what happened in the past helps in anticipating future events, prediction of future using the past and then understanding what does actually happen to improve the system's predictive ability in a upright cycle that is embedded in a continuous process of perception and action. Cognition allows a system to act effectively, to adapt, and to improve [4]. An important question here is that what makes cognition possible in humans? Are we born with cognition already embedded in our brains or do we acquire it steadily from our experiences with the environment? Can our cognitive skills be improved? What drives trigger the cognitive activities in us? Different authors have answered these questions in a diverse manner.

In [5] Brachman says that a cognitive computer system should possess the ability to reason, adapt to environment with the passage of time, learn from its experience, respond with intelligence to unfamiliar situations, be able to explain what is going on around him. Any system with these abilities will be able to identify problems with the approach it adopts in accomplishing a task and it will know when it requires updating of information to complete the task. A cognitive system has ability of viewing a problem in multiple ways and use knowledge when interacting with the environment to plan and modify its actions on the basis of that knowledge [6]. Some believes that cognition requires a necessary element of self-reflection along with other characteristics of anticipation and adaptation. Therefore cognition then can be viewed as a process by which the system achieves anticipatory, robust adaptive, autonomous behavior, having embodied perception and action. People who view cognition like a distinct part as well as sub-system with the mental faculties, this viewpoint contrasts with them. Hence cognition is a component of thoughts interested in lucid organizing as well as thinking, engaged on the representations produced by the perceptual equipment as well as 'deciding' what actions should be performed next.

3.0 DIFFERENT VIEWS OF COGNITION

What cognitive technique does, along with what sort of cognitive technique needs to be assessed along with synthesized, there are several opportunities on this and each takes a considerably different standpoint on the definition of cognition. Between these kinds of, even so, we can detect two wide-ranging classes: the actual cognitivist strategy based on remarkable data digesting representational techniques, as well as the emergent techniques strategy, taking on connectionist methods, dynamical methods, in addition to enactive methods, all based to a reduced or maybe better scope upon rules connected with self organization.

3.1 Cognitivist Approaches

Cognitivist approaches relates to the classical and still widespread believe that 'cognition is a type of computation' defined on symbol based representations and that cognitive systems 'creates this sort of representations physically while cognitive requirements as well as their own behavior is actually due to operations carried out with most of these requirements' [7]. Emergent systems comprising group of connectionist, dynamical, and enactive systems argue against the information processing view. Information processing view sees cognition as 'symbolic, rational, encapsulated, structured, and algorithmic'. Emergent systems argue in favor of a position that treats cognition as emergent, self-organizing, and dynamical [8-9]. Important distinction between the two approaches is that cognitivist systems use rule-based manipulation of symbol tokens, typically but not necessarily in a sequential manner. Emergent systems exploit processes of self-organization, self-production, self-maintenance, and self-development, through the concurrent interaction of a network of distributed interacting components. Additionally autonomy is crucial in the emergent paradigm since cognition is the process by which an autonomous system becomes viable and effective but it is just not necessarily intended with the cognitivist paradigm.

Cognitivism states that cognition involves calculations defined over interior representations as knowledge, in the course of action where specifics of the world is abstracted by means of understanding, in addition to showing with ideal representational data-structure, reasoned in relation to, and then utilized to approach to take action on the world. Cognitivism method has additionally also been named simply by numerous as the symbolic representation treatment (or information processing) method of knowledge. [10]. Cognitivism is unquestionably already been the key method to cognition up to now and is also widespread today. The discipline of cognitive science is often identified with this particular approach. It is however, by no means the only paradigm in cognitive science. For cognitivist, cognition is actually representational within a solid along with particular impression: it encompasses the manipulation of explicit symbolic representations of the state and behavior of the external world to facilitate appropriate, adaptive, anticipatory, and effective interaction. Knowledge gained from this experience is used for reasoning more effectively in the future. When talking about the creation of artificial cognitive systems in cognitivist approaches, human creator is solely responsible for the symbolic representations (or representational frameworks). This can be considerable because it implies that they'll become specifically utilized as well as comprehended or perhaps translated simply by humans whose semantic understanding can be embedded into as well as removed specifically through the system. Main problem is that many experts have argued that is also the real key limiting aspect regarding cognitivist approach. These kind of designer reliance representations efficiently bias the system as well as 'blind' the system [11-12] and constrain it to an idealized description that is dependent on and a result of human activity. As long as the system doesn't have to deviate too far from the conditions under which these descriptions were formulated this approach works. However when the system does deviate, we have a superior difference between perception and possible interpretation. This gap is normally a result of embedding the human knowledge or the enforcement of expectation-driven constraints to render a system practicable in a given space of problems.

3.2 Emergent Approaches

Emergent approach presents a very unique view of cognition compared to that of cognitvist. Emergent approach treats cognition to be a process by which an independent system becomes workable when interacting with its environment. This is done by a process in which system continuously modifies itself instantaneously to survive in the environment through moderation of common interaction between system and environment through co-determination [13]. Here the usage of term co-determination refers to the fact that the agent is specified by its environment and cognitive processes establish the semantics of input stimuli for the agent. Stated differently it can be said that agent constructs its view of the outer world form its interaction with the outer world. With this wording cognition is occasionally seen as the automatic production of wisdom, which is intrinsically specific to the incarnation, relying on the systems history of interactions, which we can call its experiences. Hence for emergent approach it is the affluence of the action interface, which determines how effective the process of perception is executed for the acquisition of sensory data. For these systems perception is not a process in which abstraction of the complete environment is comprehended and represented in a more or less similar way. The difference between emergent approach to that of cognitivist approach is that in emergent system we believe that the principal way for cognitive learning is construction of predictive skills and it is not just a process of knowledge possession. Also in emergent systems we have a continuous improvement by which processes that handle action-selection learn from their experiences and improve their capacity to handle action-selection. These processes also serve as the root competence for all intelligent systems.

3.2.1 Connectionist Systems

In connectionist systems there is no usage of logical rules to process the incoming stimuli (internal/external) for effective behavior rather they depend on concurrent execution of non symbolic activation patterns dispersed using numerical properties. Estrangement with sequential and limiting nature of symbol manipulation systems led to the development of ideas for emergent systems. These new systems were dynamic, concurrent, real-time and distributed framework.

3.2.2 Dynamical System Models

To compensate for the deficiencies in classical approaches in AI, dynamical systems theory was proposed [14] and the new proposed approach was used for the modeling of artificial and natural cognitive systems [9]. Supporters of the dynamical systems method to cognition claim that by nature motoric as well as perceptual systems are dynamical and this because both the ability of self-organization to alter their behavior according to different situations. Majority of the dynamical system are open profuse hierarchical system. It is considered a system because a large number of components interact with give rise to a large number of degrees of freedom. These systems are profuse because they distribute energy. Branching nature, which means concurrent execution of many activities is fundamental for these systems as this provides the ability to generate complex behavior. Interesting point is that the distribution in these systems in non-uniform and it may be the case that only a subset of the system contributes to the degrees of freedom to system's behavior. Such subsets of the system are called collective variables (sometimes order parameters). Each collective variable characterize the evolution of the system from a certain aspect where multiple states form coalition to achieve a common goal. This dynamic ability of subsystems interaction distinguishes the behavior of a multi dimensional dynamical systems from the connectionist systems [9].

Particular ailments ought to prevail before a dynamical process qualifies as being a cognitive program. All components must be somehow and be able to interact with one another. Another important aspect of such systems is that they should not be dependent on external environment and any state change must be dependent on other states of the system. This requirement is very evocative for equipped resolution in enactive systems. Those who support dynamical systems theory agree that such systems provide multi dimensional attributes that are usually associated with natural cognitive systems. These are the attributes of multi stability, flexibility, model detection, intuitionalism, and knowledge. Only because these systems are self-organized and dynamical, these attributes are exhibited by them. They are not dependent on any explicit human knowledge incorporated into the system.

Many proponents also claim that higher order cognitive functions of planning and learning/knowledge can also be achieved by these systems and that too with very ease at least in principle. For example learning can be described as a process in which the system when faced with unfamiliar situation handles that situation successfully by modifying its internal structure so that future occurrences of such events can be tackled without hit and trail. Therefore the process of learning modifies the system as a new behavior is learned. There are many propositions of dynamical models some of which are mentioned in [10]. Like some say that cognition is non symbolic, non representational and all mind/brain activity is evolving, positioned, historical and incorporated. The social aspect of cognition is also very important which says that every agent has certain social obligations towards other agents, which give rise to certain levels of cognition between the interacting agents. Moreover dynamical cognitive systems are necessarily incorporated. This is because such systems are composed of several self-dependent and self-organizing processes. Collaborative working of these processes differentiates a system giving it the ability of exploration of the environment by interaction.

3.2.3 Enactive System Models

Enactive systems are sort of enhancement over the emergent paradigm. In contrast to cognitivism where we needed programmer incorporated explicit knowledge handling different limited situations, in enactive systems [15] cognition is achieved by highlighting those processes, which are required for the survival of the agent. These processes are highlighted/selected by the agent depending on the dynamicity of its interaction with the environment. Advantage is that no incorporation of knowledge which means there is no need for knowledge representations. In these systems we have a concept of dynamic real time interpretation of situations, which are handled by interpreting their context. These system use cognition to discover unstipulated regularity/order that only becomes meaningful because of the ability of continuous operation and adaptation of the cognitive system. The enactive systems strongly discourage the belief that the perception of the world by the agent is not dependent on the cognitive system. On the other hand both knower and known evolve together because of their mutual relationship and dependency [15]. The objective of enactive systems is the development of such systems, which are independent, cognitive and social systems. Self-production is the major reason for the proposition of enactive system by which a system surfaces as a reasoned entity, separate from its environment, as a result of processes of self-organization.

3.3 Hybrid Models

Substantial efforts have been spent to create such an architecture, which would possess the combine attribute of both emergent systems and cognitivist systems. These systems are called hybrid systems. Main reason for the proposition of hybrid approach was that the use of systems that are explicitly human knowledge based do not have the required capability to ever exhibit cognitive functions. Although these systems use knowledge representations and semantic network but this representation is solely constructed by the system itself from its experiences and interaction with the environment. So the focus is more on the learning based exploration of the world by the agent instead of a priori knowledge. In these systems everything is represented as abstract objects, which are invariant permutation of perception and responses. Here the term invariant refers to the freedom from the geometric properties of external stimuli [16]. Actually hybrid systems behave very much like emergent systems when it comes to interaction in a unfamiliar environment still keeping the limited benefits of explicit programmer specified representations.

4.0 COGNITIVE ARCHITECTURES

Cognitive architectures refer to different theories that have been proposed to solve the various problems of cognition that are faced when trying to replicate human cognition into the machines. These are the problems of problem solving, concentration, memory, deliberation and knowledge. To complicate things these attributes have various interpretations that vary from one field to another like neuroscience, psychology and computer science. The core idea of cognitivist approach is that some features of cognition are non-variable with the passage of time and needs more importance. Those architectures which represent the non variable part of cognition needs some initial incorporated knowledge or some way of acquiring the knowledge as they definitely do not have the ability to complete any task on their own. Cognitive model is thus an arrangement of cognitive architecture along with a knowledge database. Human designer is dominantly the main source of knowledge in cognitivist. However various the use of machine learning techniques is also common to reduce the dependency on human. Regarding emergent strategies, the desire to discover an architecture comes from the built-in difficulty of a cognitive method and also the desire to offer some form of structure inside of which usually in order to embed the parts pertaining to perception, variation, expectancy, and also motivation that allow the ontogenetic progress above the system’s lifetime. From one point of view cognitive architectural mastery of an emergent method corresponds towards inborn features which are endowed because of the system's architecture along with which often do not have to be learned over time however which may be designed additionally. These properties facilitate the system to evolve. In this way system can be viewed as evolving from an initial limited functionality to subsequent autonomous development, a development that may impact directly on the architecture itself.

4.1 Global Workspace Theory

Global Workspace Theory (GWT) proposed by Bernard Baars is a cognitive architecture that defines a working relation between conscious and unconscious processes that collaborate to accomplish a task. Simulating GWT to interpret human functioning of brain is an ongoing research to improve the current cognitive models. Global Workspace Theory functions on the concept of Working Memory, which is a memory residing between sensory memory and long term memory. Working Memory is used as a temporary workpad holding momentarily active subjectively experienced events. For example if we read a telephone number just once then that number temporarily stays in our WM until we forget that number. Repeating the same number however will transfer the number from working memory to long term memory. Shanahan and Baars [17-20] have proposed GWT as a human brain functioning inspired neurons level architecture in which cognitive functions are achieved by coalitions of different processes when interacting with the environment. In this architecture we have external and internal sensory motor loop in which stimulus passes through multiple cognitive cycles. It is hybrid architecture as we do have explicit symbolic knowledge representations like cognitivist architectures but implicit knowledge is acquired through neural maps. These neural maps are basically sort of iconic representation of the system whose actions they intervene. Shanahan pointed that this kind of reflective representations usually are specifically correct for spatial cognition, which is a vital cognitive ability, although this is infamously difficult using standard logic-based approaches. He argues how the semantic space among physical feedback along with analogical representations is much smaller when compared together with emblematic language-like representations. His cognitive structures can be launched additionally upon the incredible importance of non linear to be a core component of the cognitive practice in contrast to as being a mere implementation problem. He proposed global workspace model [21-23] in which collection of states were dynamically selected by the number of diverse independent processes running in the system. These independent processes are specialist for different tasks and can cooperate with eachother for access to a global workspace giving rise to a competition among them. The winning collection of states gets access to the global workspace from where they can globally broadcast information to the processes, which are still competing. Shanahan argues that this architectural mastery provides a classy treatment for this shape trouble. There are two core elements of Shanahan's cognitive architecture a first order sensory motor loop that is closed for interaction with the external world and a higher order sensory motor loop closed internally through associative memories. This first order loop includes the actual physical cortex along with the basal ganglia (controlling the actual engine cortex), jointly delivering a reactive action-selection subsystem. The 2nd order loop contains 2 associative cortex elements, which often conduct offline simulations from the system's sensory in addition to motor control behavior. Here motor control is linked with first associative cortex while sensory stimulus is linked with second cortex. Anticipation and planning for behaviors is accomplished in this architecture by a sort of using its imagination. GWT is a global network of specialized independent processes and there is no localized cortical area. The proposed architecture contains perceptron network implemented using generalized random access memories. Input stimulus received in the form of raw sensory data is assigned interpretations based on semantic state space, which defines the structure of incoming data. GWT attains prediction by allowing the higher-order sensory motor to navigate in a virtual track in the state space so that the global workspace visits a sequence of attractors.

GWT can be best understood by imagining a theater of mind/brain functioning. In this figure of speech consciousness resembles a highlighted area on the stage of immediate memory. The highlighted area shows the focus directed by attention under executive guidance. The rest of the whole theater is dark, which represents unconscious processes and only the bright spot is conscious. An exclusive neural hypothesis can be derived from this approach. The bright spot on the stage for sensory consciousness requires the consequent sensory prediction areas of the cortex.

Franklin has pointed out that sensory consciousness in different modalities may be mutually inhibitory, within approximately 100 ms time cycles. Activation of sensory cortex is doable both internally and externally which results in the conscious inner speech and imagery that are sensed internally. Once a conscious sensory content is established, it is distributed widely to a decentralized ''audience'' of expert networks sitting in the darkened theater, presumably using corticocortical and corticothalamic fibers. The transfer of information from conscious visual episodes to the (unconscious) hippocampal system is a clear example of such distribution of conscious information in the brain.

The main function of consciousness is to allow the coordination of functioning of large numbers of specialized processes that normally execute on their own in an environment that simulates brain functioning. We can test many brain hypotheses on the architecture, which has implemented global workspace theory to test the presence consciousness in it. We noe have empirical data to support these theories for cognitive functions. We do have a computational GWT model that has been implemented using neural networks, which bears a close similarity to Neural Darwinist models. One such model is IDA developed by Franklin and his colleagues in the form of computer agents for the US Navy. This Intelligent Distributed Agent is a working computational model of global workspace theory that is designed to handle complex artificial intelligence tasks. These are the tasks normally that are normally associated with trained human beings. Particularly IDA handles the interaction between U.S. Navy sailors acting like detailers who are responsible to interact with sailors for their job assignment. IDA is equipped with necessary cognitive features to negotiate with sailors via email, enforce various navy rules, keep in mind the individual sailors' preferences like the sailors's desired location of next job posting and travel considerations. Although IDA has components almost similar to human perception including memory but the core of the system is global workspace theory that allows the meanings of the incoming stimulus to be widely distributed. This distribution of semantic knowledge gives an opportunity to the specialized programs called codelets to respond with solutions to centrally posed problems. According to Franklin the architectures and mechanisms that basic working has been designed to model human consciousness can be expected to yield information agents that possess learnability, adaptability to dynamic environments, flexibility and intelligence when they face novel and unexpected situations. Analogous architectures have been applied to complex problems like speech recognition. Although these self-sufficient agent simulations as not justified the existence of global workspace theory in the brain but they have given the proof of existence of its their functionality.

5. WORKING OF IDA

In IDA there is a concept of continuous cognitive cycles which means that the incoming stimuli is interpreted has to go through several cycles so that it can be appropriately interpreted. This stimulus may be from internal or external sources. Only after the complete meaning of the stimulus is derived the IDA agent is able to interpret the and decide what actions it needs to perform in response to the stimulus. IDA works as a detailer whose job is to distribute responsibilities to all the other sailors and it does so by communicating with the agents in plain English language. Its responsibilities include job assignment to sailors, following different constraints imposed by US Navy when fulfilling requests of sailors, keep in mind the priorities of sailor's when accommodating requests, keep track of the current and predicted future needs of the Navy, keep track of the timeline and deadlines for various projects where sailors have been deployed. Additionally it has a negotiation functionality that enables it to negotiate with sailors by emails for different tasks. Architecture IDA is shown below.

Codelet: These are small processes designed to perform certain specialized tasks and usually runs as a thread. They are continuously looking for opportunities to form coalition with other processes for accomplishing a task.

Attention Codelet: Basic purpose of these is to train our attention on a particular nature of task. Intention codelet and Expectation codelet are its examples.

Behavior Codelet: Codelets that have been deigned to execute certain kind of tasks.

Consciousness: In IDA after receiving input from internal and external senses, interpretations are assigned to the stimulus and then by broadcasting the contents from a global workspace, cognition is achieved computationally.

Content-addressable Memory: It is a special type of memory in which there is no concept of addresses and the desired information is retrieved by using hints/cues from the stimulus. Episodic memory in us humans is an example of this memory.

Episodic Memory: It is also a content addressable memory, which stores the information about events that the agent has experienced in his life.

Expectation Codelet: These are special type of codelets, which monitors the output of some other codelets that whether the output was as expected or not.

Information Codelets: These codelets carry information and participate in coalitions that compete for attention.

Intention Codelet: These codelets monitor the information that is relevant to achieving some specific goal.

Long-term Working Memory: This is the memory where we permanently store incoming percepts and local associations assigned to these percepts for the competition of attention.

Perception: This is a process in which the incoming raw data is assigned interpretations to make sense out of it.

Perceptual Memory: This memory is used to store incoming percept until it is assigned some interpretations.

Procedural Memory: This memory is used for the storage of procedures that defines how to perform different actions.

Working Memory: This memory holds the temporary content that is being used at the moment by the agent. Hence is like a snapshot of the current activities going on in the system.

Autobiographical memory: This memory serves as a combination of episodic and semantic memory containing episodes of events of the agent's life and general knowledge and facts about the world.

Step1: In this step internal and external stimuli is received and IDA's preconscious processes residing in perception module tries to assign interpretations to incoming stimuli. Interpretations are assigned by a process of categorization and recognition on the input stimulus. Sensory memory decay time in humans is very small usually measured in milliseconds. We have a number of daemon codelets, which are always in execution form looking for opportunities for which they have expertise.

Step2: In this step perceptual memory is used for the semantic analysis for comprehending the input stimulus. This process may go through several cognitive cycles and in each cycle partial semantics are determined. These partial semantics serve as the basis for the next cycle and this process continues before full interpretations are assigned. Although the activated nodes of perceptual memory does decay but the decaying rate is slow than the time require for the completion of single cognitive cycle and information generated at each cycle is available at the next cycle. Hence this complete preconscious perceptual process is an iterative one.

Step3: In this step the percept alongwith data and its initial understanding is stored in the working memory. At this moment the percept is still unconscious. In humans is very limited and can only store 7 (plus minus 2) chunks of data for a short duration of time, which is usually few seconds. Assumption here is that this limitation results from the restricted capability of consciousness rather than of the working memory.

Step4: In this step two types of memories are used which are content addressable associative memories. Semantic memory and autobiographical memory are both contained in declarative memory. In these memories decay is so slow that it is usually negligible and their capacity is very large. Here long-term associative memory cannot be used to recall any information and usually works by recognition. However we do need recall for the functioning of IDA and for this the

IDA employees a transient episodic memory. This transient episodic memory is implemented as a content addressable associative memory having a decay rate slower than that of working memory. However this memory is way faster than declarative memory. Incoming percept alongwith its cues are used to retrieve local associations from the transient episodic memory and declarative memory. Long term working memory contains both new local associations derived in the current cycle and the local associations derived from the previous cycle.

Step5: In this step 5 codelets are directly involved in the cognitive cycle. These codelets usually run as independent threads, which have been designed to perform a special purpose task. Hence each is codelet is uni-purpose. For example in IDA attention codelets are designed to bring content to consciousness. Here the usage of term content refers to a diverse type of data ranging from images, emotions, recollections, perception, thoughts, needs, goals, etc. Any content that seems relevant to current goal to an intention codelet is brought by him to consciousness. This highlighting of content is automatic for a single cognitive cycle. Coalitions are formed when attention codelets compete for access to the global workspace and this is also automatic. In IDA voluntary attention is achieved over multiple cycles.

Step6: In this step we have a collection of codelets, which have formed coalition with each other for the fulfillment of current goal. This coalition is usually accompanied by appropriate information codelets. The codelets that are part of the coalition are also called winning codelets. They get access to the global workspace. It is at this point where the contents of global workspace is broadcasted to all the codelets in the system.

Step7: In this step 7 those codelets who responded to the global conscious broadcast are grouped. Normally these codelets are those whose parameters are restricted for information in the conscious broadcast. Here expectation codelet plays an important role by monitoring the output of attention codelets. In case the output was unexpected result differing from the desired output then appropriate actions are devised by these to help to rectify the unfulfilled expectation.

Step8 & 9: These are last steps of the cognitive cycle that have been combined together. Here an important module behavior net performs action selection and chooses a single action/behavior for execution. Choice of the behavior selected may depend on current stream or from a previously active stream. Internal drives and goals of the agent affected by its emotions and feelings do have a strong impact on the action selected. Many other factors also affect the functioning the agent like external environmental parameters and relationship between the behaviors. Selected action is executed in step 9 of the cognitive cycle. Execution of selected action results in the principal behavior codelets performing their specialized tasks. This is exhibited by the agent in the form of external motor functions or by internal modifications of the agent. Here atleast one expectation codelet accompanies the corresponding action codelet, which monitors the final outcome.

6. CONCLUSION

IDA's basic purpose was to model many aspects of human cognition by the implementation of Global Workspace Theory. The ability of the model to adapt to environment by modifying its internal structure has provision it the ability of self-perpetuation mechanisms into her architecture. These self-perpetuation mechanisms function in the iterative cognitive cycles of IDA. The architecture of IDA is component based each fulfilling a specific set of features of cognitive processes. By implementing the Global Workspace Theory in terms of computational model we have a working model of human cognition where consciousness is achieved by dynamic mutual interaction of different system components. From the applications point of view the opportunities are diverse ranging from intelligent software agents to robots having cognitive abilities. IDA delivers a model that assures a flexible and human like intelligence. These architectures, which possess human like cognitive abilities are able to learn continuously and adapt themselves to dynamic environments. This makes them suitable for unexpected situations as their knowledge database in not limited by the human designer. However IDA's computational model does not offer a comprehensive solution for human cognition and many aspects of consciousness are still either missing in IDA or not achievable. Subjective experience being one of them.

The famous Chinese Room experiment conducted by Searle is one the prominent argument against the cognitive capabilities of these computational models. He argues that these models do not possess any human like cognition rather these models are just doing symbolic computation. He gave the example of a person who does not understand Chinese language but that person has mastered the exchange process of written symbols for Turing test. The case is similar to that of a computer following instructions without understanding the instructions. So if computers are provided with comprehensive knowledge, which is enough to enable them to perform naturalistic language, they would simply be manipulating symbols. These computers will have no understanding of the language. This important lack of understanding of semantics is a major weakness of computers and will always be there preventing them from becoming truly cognitive. We can define cognitive systems as systems having psychological and sensing ability comparable to humans. Having ability to think and process information, ability to exchange information with the environment, using this information to make intelligent decisions as done by humans. Humans make decision based on the information gathered from the environment and adapt itself to maximize its chances of survival in the environment.

Finally claiming that IDA is a cognitive agent depends on how we define the term cognition. Even today we have no universally agreed definition of cognition, which shows the diversity of view regarding the definition of cognition. If we agree that artificial cognition is the ability to understand how things might possibly be, not just now but at some future time, and to take this into consideration when determining how to act. Remembering what happened at some point in the past helps in anticipating future events, using the past to predict the future and then assimilating what does actually happen to adapt and improve the system's anticipatory ability in a virtuous cycle that is embedded in an on-going process of action and perception then IDA is cognitive. Although only in a limited domain of knowledge. On the other hand if we agree that artificial cognition is the ability to reason, to learn from experience, to improve its performance with time, and to respond intelligently to things it's never encountered before would also be able to explain what it is doing and why it is doing it then IDA is not cognitive. This is because at the moment IDA is computational system with some level of consciousness achieved via the GWT but it surely lacks the ability to explain what is going on when it is interacting with the environment because such a capability would require phenomenonal consciousness or subjective experience. The question of whether phenomenonal consciousness is achievable in artificial systems is still uninsured today and lots of theories have been proposed. Although the IDA model exhibits a lot of features, which are related with human cognition but I think its too far from true human cognition. IDA needs to be able to also handle unfamiliar and non-routine situations too rather than with just deal intelligently with novel instances of routine situations.

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